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Pteridaceae in remnants of Cerrado in Maranhão state, Brazil

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Abstract. The Pteridaceae is one of the most diverse families of ferns, with representatives adapted to diverse habitats ranging from aquatic to dry environments. It is the most species-rich family of ferns in the Brazilian Cerrado, although it is still poorly known in some areas of this domain in Maranhão state. Our objective was to investigate the diversity of Pteridaceae in Cerrado remnants in Maranhão. We based our study on the morphological analyses of specimens deposited in the herbaria, as well as additional new collections made by us and collaborators. Five genera comprising 15 species were recorded. Illustrations, an identification key, taxonomic comments, habitat, and geographic distribution are provided.

Keywords. Biodiversity, ferns, flora, taxonomy

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Introduction

The class Polypodiopsida includes eusporangiate and leptosporangiate fern species (Pryer et al. 2001, 2004; PPG I 2016). Worldwide, this class comprises 10,578 species, 319 genera, 48 families, and 11 orders (PPG I 2016). In Brazil, it is represented by 1,222 species, 151 genera, and 36 families (Flora e Funga do Brasil 2022).

Pteridaceae is one of the largest families of ferns. It comprises 53 genera and 1,211 species (PPG I 2016), which is approximately 10% of the class. In Brazil, the diversity of Pteridaceae is estimated to be 24 genera and 207 species, of which 71 are endemic (Prado et al. 2020). This diversity is directly related to the fact that the life forms in this family (aquatic, epiphytic, rupicolous, terrestrial) are the most varied among ferns, the representatives of the family have adapted to a wide range of habitats (aquatic to xeric), and these adaptations differ from those found in other fern families (Schuettpelz et al. 2007).

Species of Pteridaceae are morphologically diverse. One characteristic of the group is that the sporangia, on the abaxial lamina surface, are along the veins or on the margin of the segments, and generally protected by a false indusium, or covering the entire abaxial surface (acrostichoid sori) (Tryon and Tryon 1982; Schuettpelz et al. 2007).

The generic circumscription and hierarchy in Pteridaceae are controversial, and various classifications have been proposed. For example, Ching (1940) recognized two tribes (Lonchitideae and Pterideae) in Pteridaceae. Copeland (1947) included genera from the Dicksoniaceae and Dennstaedtiaceae and did not recognize subdivisions in the family. Tryon and Tryon (1982) recognized six tribes in Pteridaceae: Adianteae, Ceratopterideae, Cheilantheae, Platyzomateae, Pterideae, and Taenitideae. Tryon (1986) divided Pteridaceae into six subfamilies: Adiantoideae, Ceratopteridoideae, Cheilanthoideae, Platyzomatoideae, Pteridoideae, and Taenitidoideae.

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In addition to morphological characters, authors have lately started to include molecular data and phylogenetic analyses. Smith et al. (2006) recognized five monophyletic groups in Pteridaceae which could be treated as families or subfamilies: Parkeriaceae or Parkerioideae, Adiantaceae or Adiantoideae, Cryptogrammaceae, Sinopteridaceae or Cheilanthoideae, and Pteridaceae *s.str.* or Pteridoideae. In the PPG I (2016) classification, there are five subfamilies of Pteridaceae: Parkerioideae, Cryptogrammoideae, Pteridoideae, Vittarioideae, and Cheilanthoideae.

In Brazil, floristic and taxonomic studies specifically of the family have been conducted in various domains at the local level, for example, Prado (1992), Prado (1997), Pietrobom and Barros (2002), Nonato and Windisch (2004), Prado (2004), Prado (2005b, 2005c, 2005d), Maciel and Pietrobom (2010), and Prado et al. (2017). Other notable works are Winter et al. (2011) and Miranda et al. (2015), who studied *Adiantum* L. The greatest diversity of Pteridaceae has been recorded in the Atlantic Forest of Brazil, which is a center of endemism for ferns in South America (Tryon 1972; Prado 2007). In the Cerrado domain, 50 species of Pteridaceae have been recorded by Prado et al. (2020).

For the Northeast Region of Brazil, there is only one published work on Pteridaceae (Pietrobom and Barros 2002). The known diversity of the family in this region has been mainly reported in floristic inventories of ferns and lycophytes, notably by Pietrobom and Barros (2003), Santiago et al. (2004), Pietrobom and Barros (2006), Matos et al. (2010), Xavier et al. (2012), and Santiago et al. (2014).

Maranhão state is in at the transition zone between three phytogeographic domains, the Amazon, the Cerrado, and the Caatinga, and this favors greater taxonomic diversity (IBGE 2004; Muniz 2006; Stella 2011), but for Pteridaceae, only 10 genera, 33 species, and three varieties have been recorded (Prado et al. 2020; Fernandes et al. 2022). Of these species, 15 occur in the Amazon domain and 21 in areas of Cerrado (Fernandes et al. 2007, 2010, 2022; Conceição and Rodrigues 2010; Conceição et al. 2015; Silva et al. 2017; Prado et al. 2020). This is almost half of the total number of 50 species recorded for the family in the Brazilian Cerrado domain (Prado et al. 2020).

There are no studies on specifically the Pteridaceae of Maranhão. The known diversity of the family is based on general floristic inventories of ferns and lycophytes (Bastos and Cutrim 1999; Fernandes et al. 2007, 2010, 2022; Conceição and Rodrigues 2010; Conceição and Ruggieri 2010; Conceição et al. 2015; Silva et al. 2017; Silva Junior et al. 2018, 2020). These studies do not include identification keys to the genera, species and varieties, nor do they include illustrations of the taxa, complete lists of georeferenced material, or comments on life forms and habitats.

The objective of our study was to investigate the diversity of Pteridaceae in Cerrado remnants in Maranhão state based on new collections, including ours, and material deposited in the Centro de Ciências Agrárias e Ambientais (CCAA) and São Paulo (SP) herbaria. An identification key, illustrations, and comments about habitat and environmental occurrence are provided for the taxa.

Study Area

The Cerrado vegetation in Maranhão are in the eastern and center-south parts of the state and cover 216,688 km^2, which corresponds to 65% of the land area of Maranhão (IBGE 2004; Sano et al. 2008). This vegetation has zones that are in contact with the Amazon Forest, the Restinga, and the Caatinga, occurring at elevations from the coast of the Atlantic Ocean to around 700 m in the Chapadões, in the municipality of Alto Parnaíba in the southern part of the state (Sano et al. 2007; Moraes 2014; Silva-Moraes et al. 2018).

The Cerrado vegetation in the state comprises the following formations: savanna (also known as Campo Cerrado, Campo Sujo do Cerrado, and Campo Limpo de Cerrado); forest (also known as Cerradão); and pioneer formations, represented by mangroves and restingas on the coast (IBGE 2011; Spinelli-Araújo et al. 2016).

Methods

Our study is mainly based on an analysis of specimens from the CCAA herbarium of the Universidade Federal do Maranhão (UFMA), and the SP herbarium of the Instituto de Pesquisas Ambientais (IPA), as well as recent collections made by us and our collaborators from the Laboratório de Sistemática Vegetal, Centro de Ciências Agrárias e Ambientais at UFMA. The recent collections were made in Parque Nacional Chapada das Mesas, Reserva Extrativista Chapada Limpa, and Mata da Itamacaoca between September 2019 and April 2020. Figure 1 shows the locations and municipalities where all the collections were made.

The collected material was processed on techniques for ferns (Silva 1984; Windisch 1992) and deposited in CCAA. Some duplicates were sent to Museu Paraense Emílio Goeldi (MG) and SP for identification or confirmation of the determinations.

We revised specimens at CCAA and SP and identified our new collections using the literature for the group, such as Tryon and Stolze (1989), Lellinger (1991), Moran (1995a, 1995b) Prado (2005b, 2005c), Maciel and Pietrobom (2010), Winter et al. (2011), Kessler et al. (2017), Prado et al. (2017), and Prado and Hirai (2020), as well as Neotropical floras (Smith and Lellinger 1995; Mickel and Smith 2004). The generic circumscription of the family follows PPG I (2016), the nomenclature follows the International Plant Names Index (IPNI 2022) and TROPICOS (2022), and morphological terms are based on Lellinger (2002).

For the species studied, taxonomic and ecological comments are provided based on the material examined and the literature. The geographic distribution of each

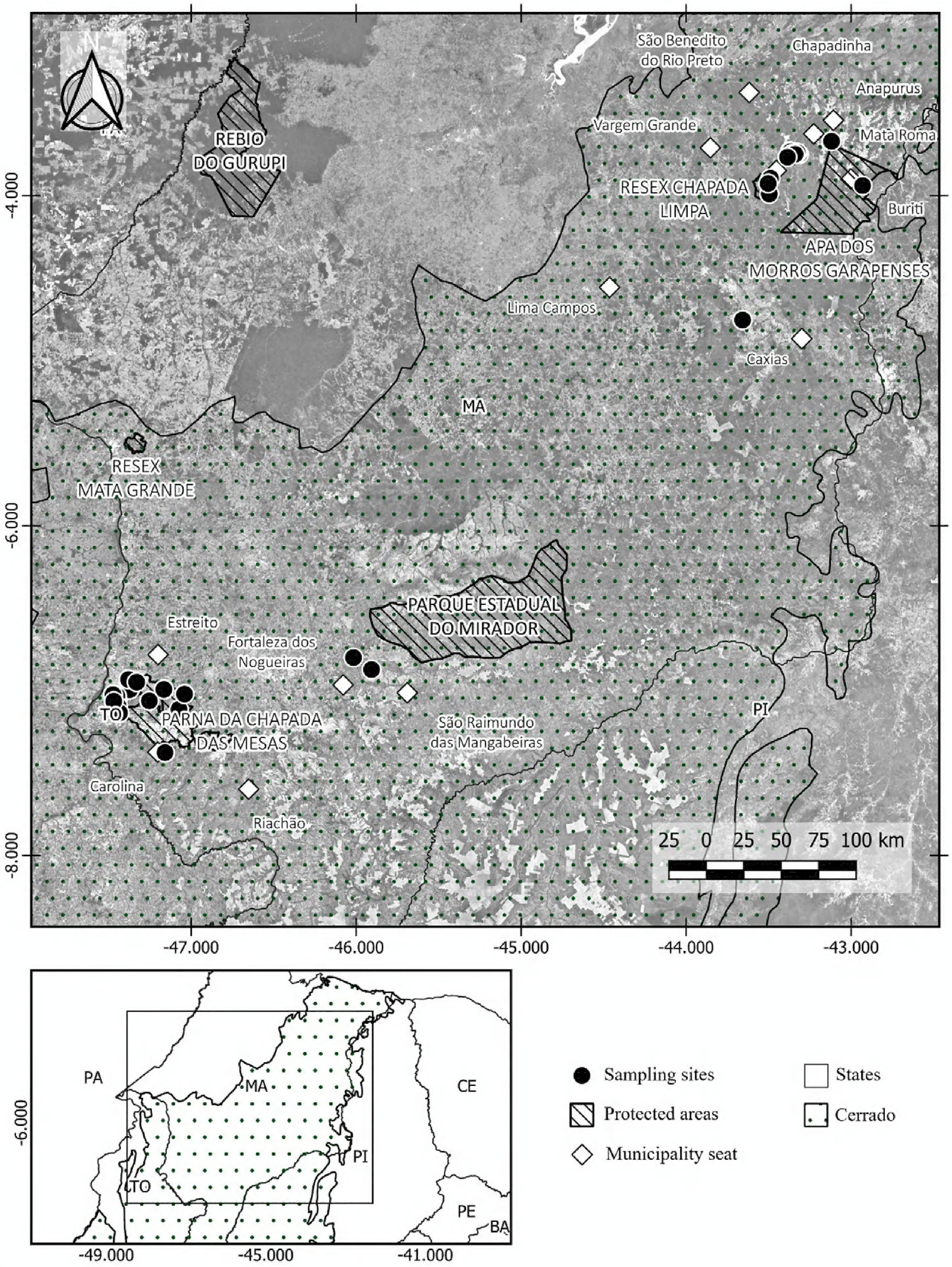

Figure 1. Map of the study area, showing sampling sites.

species follows the classification by Labiak and Prado (1998): (1) pantropical, species that occur in all tropical regions of the world; (2) Neotropical, species that occur in tropical and/or subtropical regions of America, including the southern United States; (3) species exclusive to South America; and (4) species endemic to Brazil. For geographic distribution of species, we used Moran and Riba (1995), Smith and Lellinger (1995), Mickel and Smith (2004), Labiak and Prado (2007), Kessler et al. (2017), Prado et al. (2017), and Prado et al. (2022). Flora e Funga do Brasil (2022) was used for the geographic distributions in Brazil.

Results

We identified 15 taxa of Pteridaceae from Cerrado remnants in Maranhão state. These included 15 species distributed in five genera: *Adiantum* L., *Ceratopteris* Brongn., *Cheilanthes* Sw., *Pityrogramma* Link, and *Vittaria* Sm. *Adiantum* was the most diverse, with 11 species. One species of this genus, *Adiantum* sp., has an unusual morphology with poorly formed, or aborted, spores and is probably an undescribed hybrid. Additional research is needed to better understand this material. The data has already been added to Flora e Funga do Brasil (2022).

Most species are terrestrial/rupicolous (46.6%), followed by exclusively terrestrial (20%), rupicolous (20%), epiphytic (6.7%), or aquatic (6.7%).

Most species have a Neotropical distribution (10 species), one is pantropical, one is exclusive to South America (*Adiantum sinuosum* Gardner), and two are endemic to Brazil (*Adiantum intermedium* Sw. and *Cheilanthes pohliana* Mett.).

Information on each taxon is provided in alphabetical order by genus, then species, following the key.

Key to the Pteridaceae taxa in Cerrado remnants in Maranhão state, Brazil

1 Plants fixed aquatics; fronds dimorphic ..... ***Ceratopteris thalictroides***
1′ Plants terrestrial, epiphytic, or rupicolous; fronds monomorphic or subdimorphic..... **2**
2 Plants epiphytic; laminae entire, linear; rhizome scales clathrate ..... ***Vittaria lineata***
2′ Plants terrestrial or rupicolous; laminae decompound, pedate, pinnate or more divided; rhizome scales not clathrate **3**
3 False indusia absent; sporangia along the veins; laminae with a conspicuous, farinose, whitish indument abaxially ..... ***Pityrogramma calomelanos* var. *calomelanos***
3′ False indusia present; sporangia marginal; laminae lacking a farinose indument abaxially **4**
4 Laminae 2-pinnate-pinnatifid; false indusia without veins; sporangia formed at the ends of veins on the margins of the pinnae and protected by a revolute margin ..... ***Cheilanthes pohliana***
4′ Laminae 1–3-pinnate; false indusia with veins; sporangia formed directly on the abaxial surface of the revolute margin **5**
5. Laminae 1-pinnate or with pinnate basal pinna pair **6**
5′ Laminae 2- or 3-pinnate or more divided **8**
6 Petioles and rachises glabrous; pinnae flabellate; sori on the apex of the pinnae; false indusia oblong or lunate. ..... ***Adiantum deflectens***
6′ Petioles and rachises with scales and trichomes or only with scales; pinnae cordiform or lanceolate; sori on both sides of the pinnae (acroscopic and basiscopic); false indusia arcuate, linear, or continuous **7**
7 Pinnae glabrous on both surfaces, glaucous abaxially; sori various (more than two) per pinnae false indusia linear-arcuate, glabrous. ..... ***Adiantum petiolatum***
7′ Pinnae with scales on both surfaces, not glaucous abaxially; sori usually two per pinna, one on each side of the pinna; false indusia linear-continuous, with trichomes ..... ***Adiantum lucidum***
8 Laminae 3-pinnate; petioles and rachises glabrous; pinnules orbicular to flabellate; rhizome scales orangish to yellowish ..... ***Adiantum sinuosum***
8′ Laminae 2-pinnate; petioles and rachises with trichomes and scales or only scales; pinnules dimidiate, falcate or oblong; rhizome scales brown **9**
9 Rachises with scales and trichomes..... **10**
9′ Rachises with only scales. **11**
10 Pinnules glaucous abaxially, glabrous on both surfaces..... ***Adiantum latifolium***
10′ Pinnules not glaucous, glabrous adaxially, with lanceolate scales abaxially, base of scales pectinate. ... ***Adiantum* sp.**
11 Rachises with one type of scale, narrowly lanceolate with a pectinate base..... **12**
11′ Rachises with two types of scales, lanceolate with a pectinate base plus arachnoid scales or lanceolate with a pectinate base plus filiform scales **13**
12 Pinnae in 2–4 pairs per frond; pinnules with trichomes abaxially; false indusia with trichomes .... ***Adiantum terminatum***
12′ Pinnae in 3–6 pairs per frond; pinnules with sparse scales abaxially; false indusia glabrous..... ***Adiantum intermedium***
13 Rhizomes very long-creeping (cord-like) ..... ***Adiantum serratodentatum***
13′ Rhizomes moderately long-creeping or short-creeping (not cord-like) 14
14 Pinnae in 3–5 pairs per frond; pinnules less than 22 pairs; sori 2–7 per pinnule; false indusia oblong, with trichomes..... ***Adiantum tetraphyllum***
14′ Pinnae in 5–8 pairs per frond; pinnules more than 22 pairs; sori 1 or 2 per pinnule; false indusia linear, lunate, glabrous..... ***Adiantum pulverulentum***

Adiantum L.

Adiantum is pantropical and comprises approximately 225 species (PPG I 2016; Prado and Hirai 2020). There are approximately 110 species in the Neotropics, of which 65 have been recorded in Brazil (Prado and Hirai 2020). In the study area, 11 species of *Adiantum* have been recorded.

Adiantum is terrestrial, or rarely rupicolous, and can be easily recognized by the presence of veins on the false indusia, sporangia on the revolute margin of the lamina, and trilete spores (Prado and Hirai 2020).

***Adiantum deflectens* Mart.**, Icon. Pl. Crypt.: 94. 1834. Figure 2A

Material examined. – BRAZIL • Maranhão, Carolina,

Figure 2. *Adiantum deflectens*. **A.** Habit. *Adiantum latifolium*. **B.** Habit. *Adiantum lucidum*. **C.** Habit. *Adiantum pulverulentum*. **D.** Pinnae. *Adiantum serratodentatum*. **E.** Pinnae. *Vittaria lineata*. **F.** Habit. (B and F from Fernandes et al. 2022).

Parque Nacional Chapada das Mesas, Cachoeira da Ponta da Serra, Riacho Lajes, 06°58′47″S, 047°22′25″W; 235 m alt.; 11.III.2017; L.R. Silva, M.R. Pietrobom 25 leg.; CCAA 474 • ibid.; 06°59′41″S, 047°09′57″W; 213 m alt.; 12.III.2017; L.R. Silva, M.R. Pietrobom 38 leg.; CCAA 476 • ibid.; 07°01′17″S, 047°02′27″W; 258 m alt.; 13.III.2017; L.R. Silva, M.R. Pietrobom 57 leg.; CCAA 475 • ibid.; L.R. Silva, M.R. Pietrobom 64 leg.; CCAA 473 • ibid.; L.R. Silva, M.R. Pietrobom 60 leg.; CCAA 472 • ibid.; 05.VI.2018; F.C. Almeida, J.A.S. Silva, L. Oliveira, F.P. Ottoni 15 leg.; CCAA 991 • ibid.; Cachoeira São Romão, Rio Farinha, 253 m alt.; 07.VI.2018; F.C. Almeida, J.A.S. Silva, L. Oliveira, F.P. Ottoni 63 leg.; CCAA 992 • ibid.; Cachoeira do Prata, Rio Farinha (bacia do Rio Tocantins), 06.VI.2018; F.C. Almeida, J.A.S. Silva, L. Oliveira, F.P. Ottoni 04 leg.; CCAA 990 • ibid.; 06.VI.2018; F.C. Almeida, J.A.S. Silva, L. Oliveira, F.P. Ottoni 12 leg.; CCAA 998 • ibid.; Parque Nacional Chapada das Mesas, Cachoeira ponta da Serra, Rio Lajes, 06°58′47″S, 047°22′25″W; 238 m alt.; 08.VI.2018; F.C. Almeida, J.A.S. Silva, L. Oliveira, F.P. Ottoni 104 leg.; CCAA 987 • ibid.; riacho da RPPN Mansinha, 07°08′07″S, 047°26′07″W; 286 m alt.; 08.VI.2018; F.C. Almeida, J.A.S. Silva, L. Oliveira, F.P. Ottoni 121 leg.; CCAA 986 • ibid.; Cachoeira da Mansinha, 07°08′07″S, 047°26′07″W; 286 m alt.; 03.II.2020; S.S. Oliveira, J.A.S. Silva 03 leg.; CCAA 2377 • ibid.; 06°55′55″S, 047°22′53″W; 174 m alt.; 04.II.2020; S.S. Oliveira, M.R. Pietrobom 25 leg.; CCAA 2392 • ibid.; 06°59′38″S, 047°22′23″W; 243 m alt.; 04.II.2020; S.S. Oliveira, M.R. Pietrobom 56 leg.; CCAA 2374 • ibid.; 06°58′54″S, 047°22′26″W; 241 m alt.; 04.II.2020; S.S. Oliveira, M.R. Pietrobom 45 leg.; CCAA 2371 • ibid.; 07°03′45″S, 047°15′16″W; 230 m alt.; 05.II.2020; S.S. Oliveira, M.R. Pietrobom 86 leg.; CCAA 2391 • ibid.; Cachoeira do Dodô, 07°05′43″S, 047°26′39″W; 234 m alt.; 06.II.2020; S.S. Oliveira, M.R. Pietrobom 112 leg.; CCAA 2365 • ibid.; Resort da Pedra Caída, cachoeira do Santuário Ecológico, 07°02′44″S, 047°26′38″W; 128 m alt.; 07.II.2020; S.S. Oliveira, M.R. Pietrobom 168 leg.; CCAA 2369 • Caxias, 3° Distrito Buriti Corrente, 04°45′17″S, 043°39′31″W; 73 m alt.; 07.III.2015; M. da Conceição, D. Lucas 02 leg.; CCAA 09 • ibid.; 14.III.2015; M. da Conceição, D. Lucas 22 leg.; CCAA 07 • ibid.; 02.IV.2015; M. da Conceição, D. Lucas 38 leg.; CCAA 05 • Chapadinha, Povoado Buriti Corrente, 02.IV.2015; M.A.F. Rodrigues 140 leg.; CCAA 1023 • ibid.; Povoado Gavião, 26.V.2016; M.A.F. Rodrigues 20 leg.; CCAA 1014 • ibid.; Povoado Chororó, 28.V.2016; M.A.F. Rodrigues 40 leg.; CCAA 1005 • ibid.; bairro Aparecida, 03°43′51″S, 043°22′16″W; 63 m alt.; 28.IV.2017; Turma de Biologia 2017.1 06 leg.; CCAA 505 • ibid.; Localidade Aldeia, 03°44′52″S, 043°21′32″W; 68 m alt.; 28.I.2019; H.K.F. Silva 02 leg.; CCAA 1943 • ibid.; Localidade Xororó, 03°43′59″S, 043°21′55″W; 90 m alt.; 28.I.2019; H.K.F. Silva 04 leg.; CCAA 1934 • ibid.; RESEX Chapada Limpa, 03°59′26″S, 043°29′48″W; 60 m alt.; 11.VII.2019; R.S. Fernandes 1077 leg.; CCAA 2248 • Lima Campos, Povoado Salvador, 10.II.2019; R.S. Fernandes 1056 leg.; CCAA 1876 • ibid.; 23.II.2020; R.S. Fernandes, F.P. Ottoni 1067 leg.; CCAA 2726 • São Benedito do Rio Preto, Bairro São Paulo, 07.II.2016; V.G. Carneiro, D.B. Vianna 01 leg.; CCAA 276 • Vargem Grande, Próximo ao Igarapé Água Branca, Povoado Campo Grande, 19.IV.2020; M.L. Silva 03 leg.; CCAA 2735.

Identification. *Adiantum deflectens* has an erect rhizome, 1-pinnate lamina, flabellate, articulate pinnae with denticulate sterile margins, and an oblong to lunate false indusium.

Adiantum delicatulum Mart., which also occurs in the Northeast Region in the Caatinga domain, is similar to *A. deflectens* because of its 1-pinnate lamina and flabellate, articulate pinnae; however, it can be differentiated by its ciliate, sterile pinna margins and rounded false indusium (Kessler et al. 2017).

Distribution and ecology. Neotropical. In Brazil, it is recorded in AL, BA, CE, DF, ES, GO, MA, MG, MS, MT, PA, PB, PE, PI, RJ, RN, RO, SE, SP, and TO. It occurs in ravines, on the margins of trails, and in the interior of secondary forests (Fernandes et al. 2007). This species is very common in the study area and has been recorded as terrestrial and sometimes rupicolous, on the margin of riparian forests, trails or in rock crevices, in the shade and areas exposed to light.

***Adiantum intermedium* Sw.**, Kongl. Vetensk. Acad. Handl.: 1817(1): 76. 1817.

Figure 3A, B

Material examined. – BRAZIL • Maranhão, Carolina, Parque Nacional Chapada das Mesas, 06°58′54″S, 047°22′26″W; 241 m alt.; 04.II.2020; S.S. Oliveira, M.R. Pietrobom 47 leg.; CCAA 2370 • ibid.; Resort da Pedra caída, cachoeira do Santuário Ecológico, 07°02′44″S, 047°26′38″W; 166 m alt.; 07.II.2020; S.S. Oliveira, M.R. Pietrobom 166 leg.; CCAA 2375.

Identification. *Adiantum intermedium* is characterized by its falcate pinnules, which are glabrous on both surfaces or have sparse scales on the veins abaxially, and glabrous false indusium (Prado 2005c). On the specimens analyzed, the pinnules are slightly glaucous abaxially and the false indusium is oblong to linear-lunate.

In the study area, the species is most similar to *Adiantum tetraphyllum* Willd. because of its 2-pinnate lamina and pinnules with a slightly falcate apex. However, *A. tetraphyllum* has a moderately long-creeping rhizome, pinnules with numerous scales abaxially, and a false indusium with trichomes, while *A. intermedium* has a short-creeping rhizome, pinnules that are glabrous or have a few sparse scales abaxially, and a glabrous false indusium.

Distribution and ecology. Endemic to Brazil. In Brazil, it is recorded in DF, GO, MA, MG, MS, MT, PR, RJ, SC, and SP. According to Arantes et al. (2010), *A. intermedium* is very common in the interior of riparian forests and forms large populations. It also occurs on the

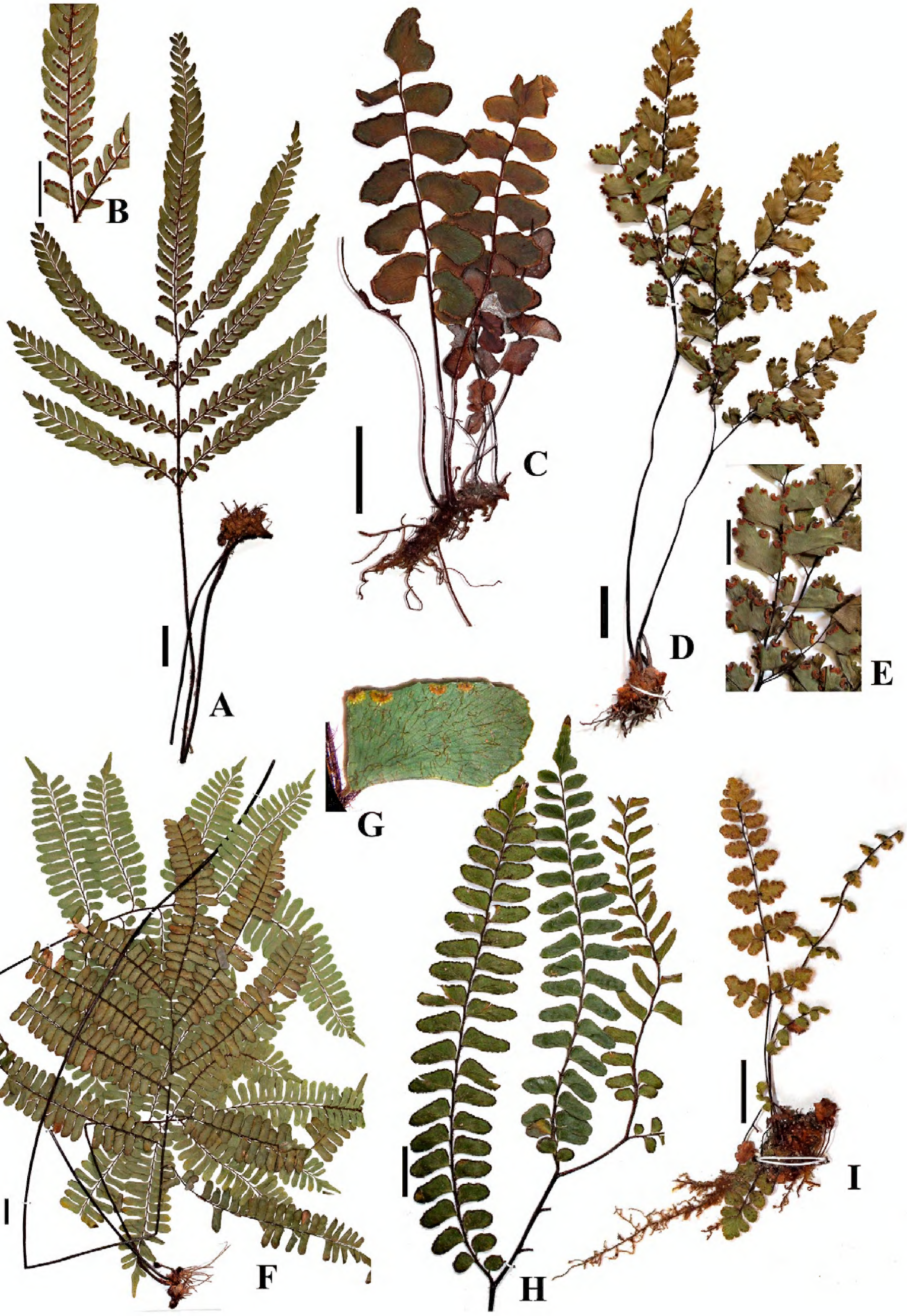

Figure 3. *Adiantum intermedium*. **A.** Fertile fronds. **B.** Fertile pinnule. *Adiantum petiolatum*. **C.** Fertile fronds. *Adiantum sinuosum*. **D.** Fertile fronds. **E.** Fertile pinnule. *Adiantum terminatum*. **F.** Fertile fronds. **G.** Fertile pinnule detail. *Adiantum tetraphyllum*. **H.** pinna. *Cheilanthes pohliana*. **I.** Fertile fronds. Scale bars: A–D, F, H = 2 cm; E, I = 1 cm.

margins of streams, in ravines, and on clayey soils (Prado 2005c). In the study areas, this species was recorded as terrestrial and rupicolous, on rock walls and the margins of riparian forests, in partial shade.

***Adiantum latifolium* Lam. in Poiret**, Encycl. 1: 43. 1783. Figure 2B

Material examined – BRAZIL • Maranhão, Carolina, Parque Nacional Chapada das Mesas, cachoeira São Romão, 07°01′17″S, 047°02′27″W; 258 m alt.; 13.III.2017; L.R. Silva, M.R. Pietrobom 66 leg.; CCAA 484 • ibid.; 06°59′36″S, 047°09′57″W; 200 m alt.; 29.X.2017; L.R. Silva, F.C. Almeida 103 leg.; CCAA 751 • ibid.; L.R. Silva, M.R. Pietrobom 99 leg.; CCAA 750 • ibid.; 07°01′15″S, 047°02′28″W; 241 m alt.; 31.X.2017; L.R. Silva, F.C. Almeida 169 leg.; CCAA 747 • ibid.; L.R. Silva, F.C. Almeida 181 leg.; CCAA 748 • ibid.; 06.VI.2018; F.C. Almeida, J.A.S. Silva 07 leg.; CCAA 982 • ibid.; 256 m alt.; 07.VI.2018; F.C. Almeida, J.A.S. Silva 56 leg.; CCAA 985 • ibid.; 256 m alt.; 07.VI.2018; F.C. Almeida, J.A.S. Silva 53 leg.; CCAA 984 • ibid.; 256 m alt.; 07.VI.2018; F.C. Almeida, J.A.S. Silva 64 leg.; CCAA 983 • Chapadinha, Povoado Gavião, 26.V.2016; M.A.F. Rodrigues 14 leg.; CCAA 1015 • ibid.; M.A.F. Rodrigues 43 leg.; CCAA 1007 • ibid.; RESEX Chapada Limpa, 03°53′45″S, 043°29′21″W; 41 m alt.; 11.VII.2019; R.S. Fernandes 1066 leg.; CCAA 2255 • São Benedito do Rio Preto, Povoado Santinho, 14.II.2016; V.G. Carneiro 05 leg.; CCAA 274.

Identification. *Adiantum latifolium* is characterized by its long-creeping rhizome, lamina glabrous on both surfaces and glaucous abaxially, 1–3 pairs of lateral pinnae, 10–16 pairs of pinnules per pinna, pinnules with a rounded or acute apex, and rachis with scales and trichomes.

Adiantum latifolium is similar to *Adiantum argutum* Splitg., which also occurs in Maranhão, due to its long-creeping rhizome, 2-pinnate lamina, and petiole and rachis with scales with a pectinate base (Prado and Lellinger 2002). However, *A. argutum* mainly differs by its pinnules with setiform scales abaxially, which are on the veins, and conspicuously biserrate, sterile pinnule margins (Kessler et al. 2017).

Distribution and ecology. Neotropical. In Brazil, this species is widely distributed and recorded in AC, AL, AM, AP, BA, CE, DF, ES, GO, MA, MG, MS, MT, PA, PB, PE, PI, PR, RJ, RO, RR, SC, and SP. *Adiantum latifolium* is usually terrestrial in Terra firme forests (Miranda et al. 2015; Prado et al. 2017) and occurs on slopes, in the interior of forests, and on the margins of trails (Pietrobom and Barros 2002). In the study area, it has been recorded as terrestrial and rupicolous, on the margin and within riparian forests, and in rock crevices, in partial sun or shade.

***Adiantum lucidum* (Cav.) Sw.**, Syn. Fil.: 121. 1806. Figure 2C

Material examined. – BRAZIL • Maranhão, Chapadinha, Itamacaoca, 03°45′00″S, 043°19′00″W; 17.VI.2015; R.S. Fernandes 984 leg.; CCAA 02 • ibid.; R.S. Fernandes, R.C. Hora 985 leg.; CCAA 56 • ibid.; R.S. Fernandes 1027 leg.; CCAA 63 • ibid.; Itamacaoca, 03°34′00″S, 043°19′00″W; 17.VII.2015; R.S. Fernandes, P.N. Carvalho, A. Farias 990 leg.; CCAA 43 • ibid.; Itamacaoca, trilha da pousada Extasy, 03°45′00″S, 043°19′00″W; 17.VII.2015; R.S. Fernandes, P.N. Carvalho, A. Farias 989 leg.; CCAA 45 • ibid.; Balneário Repouso do Guerreiro, 15.VIII.2015; R.S. Fernandes, A. Rodrigues 994 leg.; CCAA 46 • ibid.; Itamacaoca, 03°44′82″S, 043°19′36″W; 27.X.2015; R.S. Fernandes, A. Rodrigues, F.P. Ottoni 998 leg.; CCAA 39 • ibid.; Itamacaoca, 03°45′00″S, 043°19′00″W; 13.I.2016; R.S. Fernandes 988 leg.; CCAA 38 • ibid.; Trilha da pousada Estasy, 03°44′26″S, 043°19′36″W; 83 m alt.; 14.V.2016; R.S. Fernandes 1028 leg.; CCAA 55 • ibid.; Trilha da pousada Estasy, 03°44′26″S, 043°19′36″W; 82 m alt.; 14.V.2016; R.S. Fernandes 1029 leg.; CCAA 116 • ibid.; Reserva da Itamacaoca, trilha do cemitério, 82 m alt.; 04.VI.2016; R.S. Fernandes, F.P. Ottoni 1060 leg.; CCAA 95 • ibid.; Itamacaoca, 03°45′00″S, 043°19′00″W; 29.IV.2017; V.G. Carneiro 10 leg.; CCAA 903 • ibid.; Itamacaoca, trilha da pousada Extasy, 03°44′27″S, 043°19′36″W; 72 m alt.; 06.IV.2019; Turma de Biologia 2019.1 53 leg.; CCAA 1993 • ibid.; Itamacaoca, 03°44′27″S, 043°19′36″W; 72 m alt.; 06.IV.2019; Turma de Biologia 2019.1 37 leg.; CCAA 1988 • ibid.; Turma de Biologia 2019.1 22 leg.; CCAA 1987 • ibid.; Turma de Biologia 2019.1 09 leg.; CCAA 1991 • ibid.; Turma de Biologia 2019.1 51 leg.; CCAA 1994 • ibid.; Itamacaoca, 03°44′55″S, 043°19′55″W; 08.IV.2019; Turma de Biologia 2019.1 36 leg.; CCAA 1990 • ibid.; Itamacaoca, 03°44′27″S, 043°19′36″W; 72 m alt.; 24.IV.2019; Turma de Biologia 2019.1 59 leg.; CCAA 1996 • ibid.; Itamacaoca, 03°44′27″S, 043°19′36″W; 21.IX.2019; Turma de Biologia 2019.2 55 leg.; CCAA 2265 • ibid.; Itamacaoca, entrada pela Trilha da pousada Estasy, 03°44′58″S, 043°20′24″W; 72 m alt.; 22.IX.2019; Turma de Biologia 2019.2 43 leg.; CCAA 2272 • ibid.; Turma de Biologia 2019.2 44 leg.; CCAA 2260 • ibid.; Turma de Biologia 2019.2 38 leg.; CCAA 2259 • ibid.; Itamacaoca, entrada pela Trilha da pousada Estasyc, 03°44′27″S, 043°19′36″W; 09.X.2019; Turma de Biologia 2019.2 06 leg.; CCAA 2271 • ibid.; Turma de Biologia 2019.2 26 leg.; CCAA 2258.

Identification. *Adiantum lucidum* can be recognized by its pinnae that are in 10–13 pairs per frond, lanceolate, rounded on the acroscopic side and cuneate on the basiscopic side, with scattered scales abaxially and a few similar scales adaxially, veins usually free, sometimes anastomosing, two sori per pinna, one on each side of the pinna and not reaching the pinna apex, and false indusium with reddish-brown trichomes (Prado et al. 2017). In the *A. lucidum* specimens analyzed, two forms were observed: a 1-pinnate lamina with 8–18 pinna pairs and a 1-pinnate lamina with 1-pinnate basal pinna pair. This morphological variation has been recorded by other authors, such as Kessler et al. (2017).

The most similar species to *Adiantum lucidum* that also occurs in Maranhão state is *A. dolosum* Kunze because of the 1-pinnate lamina with scales on both surfaces, petiole and rachis with scales, and false indusia in continuous lines on both sides of the pinnae. However, *A. lucidum* differs by having more than 8 pairs of pinnae, with an asymmetric base and main veins free, while *A. dolosum* has 3–5 pairs of pinnae, with a symmetric base and veins regularly anastomosed (Kessler et al. 2017).

Distribution and ecology. Neotropical. In Brazil, this species is re the states of AM, AP, BA, CE, ES, MA, MG, MT, PA, PE, and RO. It is common in secondary vegetation and disturbed forests (Moran et al. 1995). In the study area, *A. lucidum* is terrestrial and rupicolous in riparian forests, on stream banks, in shady ravines, or on the sides of trails.

***Adiantum petiolatum* Desv.**, Mag. Neuesten Entdeck. Gesammten Naturk. Ges. Naturf. Freunde Berlin 5: 326. 1811.

Figure 3C

Material examined. – BRAZIL • Maranhão, Carolina, Parque Nacional Chapada das Mesas, 06°55′55″S, 047°22′53″W; 174 m alt.; 04.II.2020; S.S. Oliveira, M.R. Pietrobom 32 leg.; CCAA 2329 • São Benedito do Rio Preto, Povoado Santinho, 14.II.2016; V.G. Carneiro 03 leg.; CCAA 279 • Vargem Grande, Próximo ao Igarapé Água Branca, Povoado Campo Grande, 19.IV.2020; M.L. Silva 04 leg.; CCAA 2734.

Identification. *Adiantum petiolatum* is characterized by its short-creeping rhizome, 1-pinnate lamina that is glabrous on both surfaces, glaucous abaxially and has conspicuous idioblasts adaxially, and linear-arcuate, glabrous false indusium.

Distribution and ecology. Neotropical. In Brazil, this species is recorded in the states of AC, AL, AM, AP, BA, CE, GO, MA, MG, MT, PA, PB, PE, PI, PR, RO, RR, SC, SP, and TO. It is terrestrial and occurs on the margins of rivers (Prado et al. 2017). In the study area, it was recorded as terrestrial in riparian forests, in ravines in the shade and near the margin of a stream.

***Adiantum pulverulentum* L.**, Sp. pl. 2: 1096. 1753.

Figure 2D

Material examined. – BRAZIL • Maranhão, Carolina, Parque Nacional Chapada das Mesas, Resort da Pedra Caída, cachoeira do Santuário Ecológico, 07°02′44″S, 047°26′38″W; 128 m alt.; 07.II.2020; S.S. Oliveira, M.R. Pietrobom 135 leg.; CCAA 2389 • Chapadinha, Itamacaoca, 03°44′27″S, 043°19′36″W; 72 m alt.; 06.IV.2019; Turma de Biologia 2019.1 54 leg.; CCAA 1992 • ibid.; 03°44′58″S, 043°20′24″W; 20.VII.2019; Turma de Biologia 2019.2 34 leg.; CCAA 2266 • ibid.; Repouso do Guerreiro, 03°44′58″S, 043°20′24″W; 20.VII.2019; Turma de Biologia 2019.2 29 leg.; CCAA 2267 • ibid.; Turma de Biologia 2019.2 09 leg.; CCAA 2262 • ibid.; Turma de Biologia 2019.2 36 leg.; CCAA 2261 • ibid.; Turma de Biologia 2019.2 27 leg.; CCAA 2257.

Identification. *Adiantum pulverulentum* is characterized by its short-creeping rhizome, 2-pinnate lamina, conform terminal pinna, rachis with lanceolate scales with a pectinate base and arachnoid scales, and one linear or lunate false indusium per pinnule that is glabrous or has trichomes and is on the acroscopic side of the pinnule.

The main characteristic that differentiates this species from the others that have a 2-pinnate lamina in the study area is the presence of one linear or lunate false indusium along the acroscopic side of the pinnule (Kessler et al. 2017).

Distribution and ecology. Neotropical. In Brazil, this species is recorded in the states of AC, AL, AM, AP, BA, CE, ES, GO, MA, MG, MT, PA, PE, RJ, RR, SE, and SP. According to Winter et al. (2011), *A. pulverulentum* occurs in Capoeiras, steep areas, in the interior and margins of forests and along trails and riverbanks, and forms large populations. In the study area, it has been recorded as terrestrial and rupicolous, on a rock wall, on a canyon near a waterfall, in ravines, and on the margin of a riparian forest in partial shade.

***Adiantum serratodentatum* Humb. & Bonpl. ex Willd.**, Sp. Pl. 5: 445. 1810.

Figure 2E

Material examined. – BRAZIL • Maranhão, Carolina, Parque Nacional Chapada das Mesas, 06°56′43″S, 047°20′30″W; 175 m alt.; 11.III.2017; L.R. Silva, M.R. Pietrobom 01 leg.; CCAA 485 • ibid.; 06°56′42″S, 047°20′31″W; 155 m alt.; 30.X.2017; L.R. Silva, F.C. Almeida 110 leg.; CCAA 749 • ibid.; 06°56′44″S, 047°20′37″W; 170 m alt.; 30.X.2017; L.R. Silva, F.C. Almeida 118 leg.; CCAA 745 • ibid.; L.R. Silva, F.C. Almeida 120 leg.; CCAA 746 • ibid.; L.R. Silva, F.C. Almeida 119 leg.; CCAA 752 • ibid.; 06°56′43″S, 047°20′31″W; 179 m alt.; 08.VI.2018; F.C. Almeida, J.A.S. Silva, L. Oliveira, F.P. Ottoni 81 leg.; CCAA 989 • ibid.; F.C. Almeida, J.A.S. Silva, L. Oliveira, F.P. Ottoni 87 leg.; CCAA 980 • ibid.; 06°59′38″S, 047°22′23″W; 243 m alt.; 04.II.2020; S.S. Oliveira, M.R. Pietrobom 62 leg.; CCAA 2373 • Caxias, 3° Distrito Buriti Corrente, 04°45′17″S, 043°39′31″W; 73 m alt.; 07.II.2015; M. Conceição, D. Lucas 12 leg.; CCAA 03 • ibid.; 04°45′17″S, 043°39′31″W; 73 m alt.; 07.III.2015; M. Conceição, D. Lucas 05 leg.; CCAA 04 • ibid.; 04°45′17″S, 043°39′31″W; 73 m alt.; 14.III.2015; M. Conceição, D. Lucas 19 leg.; CCAA 08 • ibid.; M. Conceição, D. Lucas 17 leg.; CCAA 06 • ibid.; M. Conceição, D. Lucas 16 leg.; CCAA 10.

Identification. *Adiantum serratodentatum* is characterized by its long-creeping rhizome, 2-pinnate lamina, with conspicuous idioblasts present on both pinnule surfaces and sparse scales on the veins abaxially, and rachis with lanceolate scales with a pectinate base and arachnoid scales.

Adiantum serratodentatum is distinct from the other species of the genus that have a 2-pinnate lamina in the study area and grow in the Cerrado by generally more ascending pinnae and more coriaceous (Kessler et al. 2017).

Distribution and ecology. Neotropical. In Brazil, this species is recorded in the states of AM, AP, BA, GO, MA, MG, MS, MT, PA, PE, PR, RJ, RR, and SP. It is terrestrial and has been recorded in open vegetation and semideciduous forests (Tryon and Stolze 1989; Kessler et al. 2017), as well as on the margins of trails and in the interior of the Cerradão (Arantes et al. 2010; Fernandes et al. 2010). In the study area, it has been collected as terrestrial in riparian forests and on the margins of trails, in shady or partially exposed environments.

***Adiantum sinuosum* Gardner**, Icon. Pl. 6: pl. 504. 1843.
Figure 3D, E

Material examined. – BRAZIL • Maranhão, Carolina, Morro do Dodô, 07°05′39″S, 047°26′39″W; 256 m alt.; 06.II.2020; S.S. Oliveira, M.R. Pietrobom 120 leg.; CCAA 2368 • São Raimundo das Mangabeiras, 06°52′21″S, 045°54′27″W; 410 m alt.; 16.II.2017; W. R. Silva Junior, A. W. C. Ferreira 16 leg.; CCAA 581.

Identification. *Adiantum sinuosum* can be recognized by its short-creeping rhizome, with yellowish- to orangish-brown scales, up to 3-pinnate lamina at the base, flabellate to rounded pinnules, and strongly lunate, dark (when mature) false indusium (Prado 2005c; Labiak and Prado 2007).

Distribution and ecology. Exclusive to South America. In Brazil, this species is recorded in DF, GO, MA, MG, MT, PA, and TO. It generally occurs on sandy, rocky soil between rock outcrops and is also frequently near the base of shrubs, mainly in the Cerrado (Labiak and Prado 2007). In the Cerrado in Maranhão, it has been recorded as rupicolous in rock crevices and on rock walls and the margins of trails in open areas.

***Adiantum terminatum* Kunze ex Miq.,** Verslagen Meded. Vier Kl. Kon. Ned. Inst. Wetensch. Letterk. Schoone Kunsten 1842: 17. 1843.
Figure 3F, G

Material examined. – BRAZIL • Maranhão, Carolina, Resort da Pedra Caída, Cachoeira da Pedra Furada, 07°01′59″S, 047°27′01″W; 195 m alt.; 07.II.2020; S.S. Oliveira, M.R. Pietrobom 169 leg.; CCAA 2390.

Identification. *Adiantum terminatum* is similar to *Adiantum humile* Kunze by the 2-pinnate lamina, pinnules with long, septate trichomes abaxially, and sterile pinnules with a finely serrulate margin (Kessler et al. 2017). However, *A. terminatum* differs by its reduced pinnules in the direction of the base and apex of the pinnae, distal pinnules less than half the size of the median pinnules, and false indusia with trichomes (vs. glabrous). *Adiantum humile* is widespread in Brazil but does not occur in the state Maranhão.

Distribution and ecology. Neotropical. In Brazil, this species is recorded in AC, AL, AM, AP, BA, CE, DF, ES, GO, MA, MG, MT, PA, PE, PR, RJ, RS, RO, RR, and SP. It is terrestrial (or rarely rupicolous) and occurs in the interior of Terra firme forests, on clayey or sandy soils, where it forms large populations (Prado 2005b; Prado et al. 2017). In the study area, it has been recorded as rupicolous, on a rock wall of a canyon near a waterfall, in partial shade.

***Adiantum tetraphyllum* Humb. & Bonpl. ex Willd.**, Sp. Pl. 5(1): 441. 1810.
Figure 3H

Material examined. – BRAZIL • Maranhão, Carolina, Localidade Vereda Bonita, 07°01′29″S, 047°28′28″W; 154 m alt.; 06.II.2020; S.S. Oliveira, M.R. Pietrobom 104 leg.; CCAA 2367.

Identification. *Adiantum tetraphyllum* can be recognized by its moderately long-creeping rhizome, 2-pinnate lamina, scales with a pectinate base abaxially, and rachis with lanceolate scales with a pectinate base and filiform scales. The pinnules have a rounded apex and are curved in the direction of the pinna apices, and the false indusia are oblong and have trichomes.

Distribution and ecology. Neotropical. In Brazil, this species is recorded in AC, AM, BA, CE, DF, ES, GO, MA, MG, MS, MT, PA, PE, PR, RO, RR, RJ, SC, SP, and TO. In the study area, it has been recorded in Capoeira and Terra firme forest, near a water course.

***Adiantum* sp.**

Material examined. – BRAZIL • Maranhão, Carolina, Localidade Vereda Bonita, 07°01′29″S, 047°28′28″W; 154 m alt.; 06.II.2020; S.S. Oliveira, M.R. Pietrobom 105 leg.; CCAA 2328.

Identification. This specimen is characterized by its long-creeping rhizome, 2-pinnate lamina, terminal pinna that is larger than the lateral pinnae, 1 or 2 pairs of lateral pinnae, pinnules that have lanceolate scales with a pectinate base abaxially and are glabrous adaxially, and oblong, glabrous false indusia.

It is probably a hybrid involving *A. latifolium*, since it has a long-creeping rhizome, 2-pinnate lamina, and glabrous false indusium. However, more fieldwork and morphological studies are needed to confirm its parents. In the material examined, the sporangia are malformed (aborted). The failure to form sporangia is a very common characteristic of *Adiantum* hybrids.

Distribution and ecology. In the Cerrado in Maranhão, the species has been recorded in Terra firme forest, Capoeira, and near a watercourse.

***Ceratopteris* Brongn.**

Ceratopteris is pantropical and comprises six species (PPG I 2016; Kessler et al. 2017), of which two occur in

Brazil (Hirai and Prado 2022). In the study area, only one species was recorded.

***Ceratopteris thalictroides* (L.) Brongn.**, Bull. Sci. Soc. Philom. Paris 8: 186. 1821.

Material examined. – BRAZIL • Maranhão, Anapurus, Próximo da Av. Francisco Monteles; 30.I.2016; R.S. Fernandes 1004 leg.; CCAA 59 • ibid.; Balneário na margem da BR 222, 03°40′15″S, 043°07′09″W; 29.VIII.2019; Turma de Biologia 2018.2 21 leg.; CCAA 942 • Buriti, APA dos Morros Garapenses, 03°56′24″S, 042°55′52″W; 72 m alt.; 22.VII.2019; F.C. Almeida 133 leg.; CCAA 2730 • Carolina, Parque Nacional Chapada das Mesas, 06°59′37″S, 047°09′57″W; 197 m alt.; 06.VI.2018; F.C. Almeida, J.A.S. Silva, L. Oliveira, F.P. Ottoni 119 leg.; CCAA 993 • ibid.; Parque Nacional Chapada das Mesas, 256 m alt.; 07.VI.2018; F.C. Almeida, J.A.S. Silva, L. Oliveira, F.P. Ottoni 67 leg.; CCAA 994 • Chapadinha, Povoado Buriti Corrente, 02.IV.2015; M.A.F. Rodrigues 91 leg.; CCAA 1019 • ibid.; M.A.F. Rodrigues 125 leg.; CCAA 1028 • ibid.; Angelin, 03°46′02″S, 043°23′11″W; 72 m alt.; 29.X.2016; Turma de Biologia 2017.1 20 leg.; CCAA 118 • ibid.; RESEX Chapada Limpa, 03°55′39″S, 043°30′13″W; 48 m alt.; 11.VII.2019; R.S. Fernandes 1068 leg.; CCAA 2256.

Identification. *Ceratopteris thalictroides* can be recognized by its non-inflated petioles, 2- or 3-pinnate sterile lamina, with alternate proximal pinnae, and sporangia with a well-developed annulus.

Ceratopteris pteridoides (Hook.) Hieron., which also occurs in Maranhão state, is similar to *C. thalictroides* but can be differentiated by its simple sterile lamina, opposite basal pinnae, frequently inflated petiole, and poorly developed sporangia with a vestigial or no annulus (Moran 1995a).

Distribution and ecology. Pantropical. In Brazil, this species is recorded in the states of AL, AM, AP, BA, CE, ES, GO, MA, MG, MS, MT, PA, PB, PE, RJ, RN, RO, RS, SC, SE, and SP. It is found in aquatic habitats, such as lagoons, creeks, and swampy areas, and is usually rooted in mud (Moran 1995a). In the Cerrado in Maranhão, it has been recorded in periodically flooded environments, riparian forests, near *Mauritia flexuosa* L.f. forests, and isolated or together with populations of *Marsilea* L. in an open environment.

Cheilanthes Sw.

Cheilanthes is pantropical (Ponce and Arana 2016; Ponce et al. 2022) and comprises around 70 species (Ponce et al. 2022). There are approximately 40 species in South America (Ponce and Arana 2016), of which 13 species have been recorded in Brazil (Ponce et al. 2022). Only one species was recorded in the study area.

The genus is recognized by its lamina covered with trichomes on both surfaces, concolor rhizome scales, and sori restricted to the margin of the lamina and covered by a recurved lamina margin that forms a false indusium without veins (Kessler et al. 2017).

***Cheilanthes pohliana* Mett.**, Abh. Senckenberg. Naturf. Ges.: 23. 1859.
Figure 3I

Material examined. - BRAZIL • Maranhão, Carolina, Parque Nacional Chapada das Mesas, 06°55′58″S, 047°22′50″W; 175 m alt.; 04.II.2020; S.S. Oliveira, M.R. Pietrobom 35 leg.; CCAA 2364 • ibid.; Morro do Dodô, 07°05′39″S, 047°26′39″W; 256 m alt.; 06.II.2020; S.S. Oliveira, M.R. Pietrobom 122 leg..; CCAA 2394.

Identification. *Cheilanthes pohliana* is characterized by its lamina, which is 2-pinnate-pinnatifid at the base and pinnate-pinnatifid distally, the oval pinnules with long, septate trichomes on both surfaces, and the rachis and petiole with short trichomes.

Distribution and ecology. Endemic to Brazil. This species has been recorded in the states of GO, MA, MG, MT, PA, and TO. It tolerates dry environments and generally colonizes rocks (Tryon and Tryon 1982; Ponce and Scataglini 2018). In the study area, it grows on large, exposed rock walls.

Pityrogramma Link.

Pityrogramma is pantropical and comprises 20 species (Mickel and Smith 2004; PPG I 2016; Kessler et al. 2017; Prado et al. 2017). In Brazil, it is represented by four species and two varieties (Prado and Hirai 2022a). In the Cerrado in Maranhão, only one species was recorded.

The genus is terrestrial and can be easily recognized by the white to yellowish wax on the abaxial laminar tissue. The wax is produced by glandular trichomes.

Pityrogramma calomelanos* (L.) Link var. *calomelanos, Handbuch 3: 20. 1833.

Material examined. – BRAZIL • Maranhão, Anapurus, 03°40′15″S, 043°07′09″W; 29.VIII.2018; Turma de Biologia 2018.2 23 leg.; CCAA 929 • Carolina, Parque Nacional Chapada das Mesas, 06°56′56″S, 047°19′53″W; 184 m alt.; 11.III.2017; L.R. Silva, M.R. Pietrobom 18 leg.; CCAA 483 • ibid.; Parque Nacional Chapada das Mesas, 06°59′37″S, 047°09′58″W; 194 m alt.; 29.X.2017; L.R. Silva, F.C. Almeida 87 leg.; CCAA 737 • ibid.; Parque Nacional Chapada das Mesas, 06°59′36″S, 047°09′57″W; 200 m alt.; 29.X.2017; L.R. Silva, F.C. Almeida 102 leg.; CCAA 742 • ibid.; Parque Nacional Chapada das Mesas, 07°06′51″S, 047°04′27″W; 292 m alt.; 31.X.2017; L.R. Silva, F.C. Almeida 175 leg.; CCAA 741 • ibid.; Parque Nacional Chapada das Mesas, 07°01′15″S, 047°02′28″W; 241 m alt.; 31.X.2017; L.R. Silva, M.R. Pietrobom 170 leg.; CCAA 740 • ibid.; L.R. Silva, F.C. Almeida 186 leg.; CCAA 738 • ibid.; Parque Nacional Chapada das Mesas, 06.VI.2018; F.C. Almeida, J.A.S. Silva, L. Oliveira, F.P. Ottoni 06 leg.; CCAA 996 • ibid.; Parque Nacional Chapada das Mesas, 256 m alt.; 07.VI.2018; J.A.S. Silva, L. Oliveira, F.P. Ottoni 58 leg.; CCAA 997 • ibid.; Parque Nacional Chapada das Mesas, Cachoeira da Mansinha; 07°08′07″S, 047°26′07″W; 286 m alt.; 03.II.2020; S.S. Oliveira, M.R. Pietrobom 05 leg.; CCAA 2376 • ibid.; Parque Nacional Chapada das

Mesas, 07°22′33″S, 047°09′32″W; 254 m alt.; 05.II.2020; S.S. Oliveira, M.R. Pietrobom 79 leg.; CCAA 2372 • ibid.; Parque Nacional Chapada das Mesas, 07°03′45″S, 047°15′16″W; 05.II.2020; S.S. Oliveira, M.R. Pietrobom 88 leg.; CCAA 2388 • Chapadinha, Povoado Buriti Corrente; 05.IV.2015; M.A.F. Rodrigues 103 leg.; CCAA 1020 • Caxias, 3° Distrito Buriti Corrente, 14.III.2015; M. Conceição, D. Lucas 25 leg.; CCAA 11.

Identification. *Pityrogramma calomelanos* var. *calomelanos* can be recognized by its 2-pinnate-pinatifid lamina, chartaceous, ascendant pinnules, and farinose abaxial surface with dense, white farina (wax). *Pityrogramma calomelanos* var. *aureoflava*, which also occurs in the Brazilian Cerrado (Prado and Hirai 2022a), is similar to *P. calomelanos* var. *calomelanos* by the characters mentioned but differs by having yellowish wax on the abaxial surface of the pinnules (Tryon 1962).

Distribution and ecology. Neotropical. In Brazil, this species is widely distributed and recorded in AC, AL, AM, AP, BA, CE, DF, ES, GO, MA, MG, MS, MT, PA, PB, PE, PI, PR, RJ, RN, RO, RR, RS, SC, SE, SP, and TO. It is very common in the neotropical region and mainly occurs in disturbed areas, on the margins of roads, slopes, forests, and riverbanks, and rarely in forests (Moran 1995b; Kessler et al. 2017). In the study area, it has been found as terrestrial or rupicolous in ravines, rocky areas, and near water courses, in open, sunny areas.

Vittaria Sm.

Vittaria is pantropical (Prado et al. 2017) and comprises around seven species (PPG I 2016; Schuettpelz et al. 2016). In Brazil, it is represented by three species (Schuettpelz et al. 2022). Only one species was recorded in the study area.

The genus is epiphytic or sometimes rupicolous and easily recognized by the narrow, linear fronds (~2–3 mm wide) and linear sori that are parallel to the margins of the lamina. The scales on the rhizome are clathrate and reddish brown.

***Vittaria lineata* (L.) Sm.**, Mém. Acad. Roy. Sci. (Turin) 5(1790–1791): 421, pl. 9, fig. 5. 1793.

Figure 2F

Material examined. – BRAZIL • Maranhão, Carolina, Parque Nacional Chapada das Mesas, 07°01′17″S, 047°02′27″W; 258 m alt.; 13.III.2017; L.R. Silva, M.R. Pietrobom 63 leg.; CCAA 471 • ibid.; 07°01′15″S, 047°02′28″W; 241 m alt.; 31.X.2017; L.R. Silva, F.C. Almeida 159 leg.; CCAA 739 • ibid.; 256 m alt.; 07.VI.2018; F.C. Almeida, J.A.S. Silva, L. Oliveira, F. P. Ottoni 45 leg.; CCAA 995 • ibid.; Resort da Pedra Caída, Rio Vão Feio, próximo a cachoeira da Caverna, 07°03′53″S, 047°28′12″W; 258 m alt.; 07.II.2020; S.S. Oliveira, M.R. Pietrobom 188 leg.; CCAA 2366.

Identification. *Vittaria lineata* is characterized by its entire, linear lamina, venation forming a single row of areoles between the costa and blade margin, submarginal, continuous sori with filiform paraphyses, and monolete spores.

Distribution and ecology. Neotropical. In Brazil, this species is recorded in the states of AC, AM, AP, BA, CE, ES, MA, MS, MT, PA, PE, PR, RJ, RO, RS, SC, and SP. It generally occurs on palms, in Terra firme forest, near creeks (Windisch and Nonato 1999; Silva Junior et al. 2020). In the study area, this species has been found as an epiphyte on live tree trunks, near the margin of a trail, and as on rocks near a waterfall, in the shade and sun.

Discussion

The Pteridaceae listed in this study represent around 42% of those taxa recorded from Maranhão state (33 species and three varieties) (Bastos and Cutrim 1999; Fernandes et al. 2007, 2010, 2022; Conceição and Rodrigues 2010; Conceição et al. 2015; Prado et al. 2022; Silva et al. 2017; Silva Junior et al. 2018, 2020). In inventories of ferns and lycophytes in Cerrado areas in Maranhão, one of the most species-rich families is Pteridaceae (Fernandes et al. 2007, 2010, 2022; Conceição et al. 2015; Silva et al. 2017).

Various Pteridaceae species are restricted to the Amazonian domain in Maranhão state, such as *Acrostichum aureum* L., *A. danaeifolium* Langsd. & Fisch., *Adiantum argutum*, *A. cajennense* Willd. ex Klotzsch, *A. dolosum*, *A. glaucescens* Klotzsch, *A. paraense* Hieron., *Ananthacorus angustifolius* (Sw.) Underw. & Maxon, *Polytaenium guayanense* (Hieron.) Alston, and *Pteris tripartita* Sw. (Maciel and Pietrobom 2010; Fernandes et al. 2012; Moura and Salino 2016; Silva Junior et al. 2018, 2022; Prado and Hirai 2022b), although some of them like *Acrostichum aureum*, *A. danaeifolium*, *Adiantum dolosum*, *A. glaucescens*, and *Pteris tripartita* also occur in the Atlantic Forest domain (Prado et al. 2022).

On the other hand, when we observed species that occur in two domains in Maranhão—like the Cerrado and Amazon—this can be justified by the presence of transition areas in the state between these biomes. Such species are: *Adiantum deflectens*, *A. latifolium*, *A. lucidum*, *A. petiolatum*, *A. pulverulentum*, *A. terminatum*, *Ceratopteris thalictroides*, *Pityrogramma calomelanos* var. *calomelanos*, and *Vittaria lineata* (Silva Júnior et al. 2020; Fernandes et al. 2022).

Adiantum is the fern genus with the greatest species diversity in Maranhão (16 species) (Prado and Hirai 2022b; Fernandes et al. 2022) and in the study area, where 11 species are known. Among the notable species, *A. deflectens*, *A. intermedium*, *A. sinuosum*, and *A. serratodentatum* have been cited in many floristic studies of ferns and lycophytes in Cerrado areas (Prado 1997, 2005c; Athayde Filho and Agostinho 2005; Arantes et al. 2010; Fernandes et al. 2010; Miguez et al. 2013; Salino et al. 2013; Zambiase et al. 2016).

One collection of *Adiantum* (*Adiantum* sp.) is probably a hybrid, as suggested by its unusual morphology and malformed (aborted) sporangia. However,

additional study is needed to determine the probable parents of this taxon. There is a confirmed hybrid, *Adiantum* × *moranii* J. Prado (Prado 2005a) in Brazil, and other specimens that may be hybrids are known for the genus (Prado and Hirai 2020). The preferred environments of hybrids in the genus are forest fragments, disturbed vegetation formations, and stream banks that are usually affected by flooding (Moran and Watkins 2002). The specimen collected was in a secondary forest, near a watercourse.

One important occurrence for the Cerrado in Maranhão is the genus *Cheilanthes*, which has species that are tolerant to dry environments (Tryon and Tryon 1982; Ponce and Scataglini 2018). In the Brazilian Cerrado, five species of the genus have been recorded. In our study, and in other areas of Cerrado in Brazil, *Cheilanthes pohliana* has been recorded in rocky areas, generally in rock crevices (Fernandes et al. 2014; Della et al. 2019).

The diversity of epiphytic ferns in the Polypodiaceae and Nephrolepidaceae in the Cerrado in Maranhão is low (Conceição and Rodrigues 2010; Silva et al. 2017). In the study area, one epiphytic species of Pteridaceae, *Vittaria lineata*, was recorded growing on a live tree trunk in a riparian forest near a waterfall. The occurrence there of this species is like due to adaptations of the leaves, such as laminae covered by a thick cuticle, which allow it to survive long periods of drought (Dubuisson et al. 2009). According to Ribeiro and Walter (1998), in the Brazilian Cerrado, epiphytic species are usually more diverse than in riparian forests, where the relative humidity in the interior is high during dry periods of the year.

Of the 15 taxa recorded in this study, 14 species occur in Parque Nacional Chapada das Mesas (Fernandes et al. 2022) and three occur in Reserva Extrativista Chapada Limpa, which are both protected areas (conservation units) of Cerrado in Maranhão. *Adiantum intermedium*, *A. terminatum*, *A. tetraphyllum*, *Adiantum* sp., *Cheilanthes pohliana*, and *Vittaria lineata* are notable for having been recorded only in Parque Nacional Chapada das Mesas. The greater number of species in this park is related to more diverse environments and because more fieldwork has been conducted there (Fernandes et al. 2022). Despite that only three species were recorded in Reserva Extrativista Chapada Limpa, this number is greater than that recorded in other protected areas: Área de Preservação Ambiental do Inhamum, with two species (Fernandes et al. 2007); and Parque Estadual do Mirador, with only one species (Conceição and Rodrigues 2010).

For the Cerrado domain in Maranhão, studies that have included Pteridaceae species are floristic works that were conducted mainly in the Caxias microregion in eastern Maranhão (Fernandes et al. 2007, 2010; Conceição et al. 2015; Silva et al. 2017). For the southern Maranhão, three studies have been published on the ferns or lycophytes: Conceição and Rodrigues (2010), Almeida et al. (2020), and Fernandes et al. (2022). The first study was conducted in Parque Estadual do Mirador, which is the largest conservation unit in the state (766,781 ha) (Maranhão 2009), and only seven species (one Pteridaceae) of ferns and lycophytes were recorded there. The second study was only on the lycophytes in Parque Nacional Chapada das Mesas and recorded six species. The third study was a floristic survey of ferns and lycophytes in Parque Nacional Chapada das Mesas, and the Pteridaceae had the greatest number of species.

Although species of *Pteris* L. (*P. denticulata* Sw.) and *Adiantopsis* Fée [*A. chlorophylla* (Sw.) Fée, and *A. radiata* (L.) Fée] are mentioned in the Flora of Brazil for the Cerrado in Maranhão (Prado et al. 2022), these species were not found in the study area of this floristic survey.

Our results show that the Cerrado in Maranhão harbors a diverse flora of Pteridaceae, with representatives that occur in diverse habitats and have various life forms. Although the most representative fern family in floristic studies in Maranhão is Pteridaceae, the diversity of this group is still undersampled in the state because collection sites in the Cerrado are few. Additional fieldwork is needed to fill information gaps in the Cerrado and other phytogeographic domains in Maranhão.

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Authors' Contributions

Conceptualization: RF. Data curation: PHCA, JP. Investigation: PHCA. Methodology: RF. Supervision: RF. Writing – original draft: PHCA, RF. Writing – review and editing: RF, JP.

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